

1

RADIATION IMAGING APPARATUS AND PHANTOM USED FOR THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a 371 U.S. National Stage of International Application No. PCT/JP2011/060731, filed May 10, 2011. This application claims priority to Japanese Patent Application No. 2010-109144, filed May 11, 2010. The disclosures of the above applications are incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to a radiation imaging apparatus that images an object using radiation and a phantom used in the apparatus, and in particular, to a radiation imaging apparatus that produces images such as panoramic images of an object according to a tomosynthesis technique and the phantom used by the apparatus for calibration thereof and a structural analysis of the imaging space provided by the apparatus.

BACKGROUND ART

In recent years, tomographic imaging using a tomosynthesis technique has been used actively. The theory of this tomosynthesis technique has been known long before (for example, refer to patent document 1), and recently, tomographic imaging that enjoys ease of image reconstruction performed using the tomosynthesis technique has been proposed (for example, refer to patent documents 2 and 3). Especially, many such cases can be found in dental and mammographic fields (for example, refer to patent documents 4, 5 and 6).

Conventionally, as one of radiation imaging apparatuses that employ the tomosynthesis technique by choice, there is a dental panoramic imaging apparatus. In this panoramic imaging apparatus, since an X-ray detector (hereinafter, referred to as a detector) has a limitation in its movement, the apparatus is designed to focus on a tomographic plane (which is referred to as a referential tomographic plane) according to a trajectory which is set mechanically in an imaging space. The imaging space refers to a space in which there is an X-ray path connecting the X-ray tube and the detector which are rotated around the jaw of a patient.

Therefore, the focuses of produced images are optimized best only when the tooth row exists at and along the referential tomographic plane in the imaging space. However, when the tooth row is out of alignment from the referential tomographic plane, images are produced with poor focusing, so that the images blur. From this point of view, when it is desired to observe blurred portions of produced images at higher resolution, positioning of the patient is performed again to focus the blurred portions more clearly and data are acquired again, or, the blurred portions are subjected to intraoral imaging to obtain clearer images.

Meanwhile, in recent years, an X-ray panoramic imaging apparatus described in patent document 7 has been developed, in which a detector capable of acquiring X-ray detection data at a faster speed (for example, 300 FPS) is used and all the detection data are inputted into a computer to apply the tomosynthesis technique to the detection data. In this apparatus, the detection data are processed based on the tomosynthesis technique to produce panoramic images of tomographic planes. In this apparatus, the position of a

2

tomographic plane can be changed in the front-back direction of the plane and a panoramic image of the changed tomographic plane can be produced. For this image production, information indicative of distances of plural tomographic planes which are spatially parallel to the detection surface of the detection (such information is called as shift & add quantities or gains) is obtained by using a phantom or by theoretical calculation. For imaging, a pair of the X-ray tube and the detector is rotated around the patient's jaw, during which data are acquired. The central position of this rotation approaches to the tooth row and departs from it during the imaging. The acquired data are then subjected to software processing based on the tomosynthesis technique that uses the foregoing distance information, which provides images with less blur.

PRIOR ART REFERENCE

Patent Reference

- [Patent Reference 1] JP-A-S57-203430
- [Patent Reference 2] JP-A-H6-88790
- [Patent Reference 3] JP-A-H10-295680
- [Patent Reference 4] JP-A-H4-144548
- [Patent Reference 5] JP-A-2008-110098
- [Patent Reference 6] US2006/0203959 A1
- [Patent Reference 7] JP-A-2007-136163

DISCLOSURE OF THE INVENTION

Issues to be Solved by the Invention

In the panoramic imaging apparatus described in the foregoing patent reference 7, it is assumed that plural tomographic images to be reconstructed exist at positions on lines each connecting the detector and the X-ray tube at each rotational angular position. Under this assumption, the tomosynthesis technique is used to produce panoramic images of respective tomographic planes. Thus, in cases where tomographic planes are changed from one to another, e.g. another tomographic plane is designated for producing its panoramic image, the enlargement factor of the image changes. Due to such changes, a produced image will be distorted in its longitudinal direction (the vertical direction of the tooth row). As images are digitized, it is possible to produce images with less distortion in their vertical and lateral directions provided that the tooth row is exactly positioned at and along the referential tomographic plane.

However, when this positioning condition is not met, distortion always occurs in images. Further, when a tooth row is not positioned along the referential tomographic plane, there will also be caused blur in the lateral direction of a reconstructed panoramic image. In such a case, it is possible to lessen the lateral distortion (blur) if imaging processing is able to provide focused images. However, in that case, due to the fact that the longitudinal distortion is not related to the shift & add quantities, there will be left longitudinal distortion in panoramic images. If there is distortion in an image, a distance between two points in an image cannot be depicted accurately compared with the actual distance. Obviously, there are various inconveniences, such as, being unable to accurately measure a distance between two points, which result in panoramic images which provide poor measurement capabilities.

The reason why the foregoing longitudinal distortion occurs is as follows. During the data acquisition, the X-ray tube and the detector rotate around a patient's tooth row while they are directly opposed to each other at mutually different